

Non-Silicon and Non-Boron based Leading Edges for Hypersonic Vehicles

NOTE: The Solicitations and topics listed on this site are copies from the various SBIR agency solicitations and are not necessarily the latest and most up-to-date. For this reason, you should use the agency link listed below which will take you directly to the appropriate agency server where you can read the official version of this solicitation and download the appropriate forms and rules.

The official link for this solicitation is: <http://www.acq.osd.mil/osbp/sbir/solicitations/index.shtml>

Agency:
Department of Defense

Release Date:
November 20, 2013
Branch:
Air Force

Open Date:
November 20, 2013
Program / Phase / Year:
SBIR / Phase I / 2014

Application Due Date:
January 22, 2014

Solicitation:
[2014.1](#)

Close Date:
January 22, 2014
Topic Number:
AF141-001

Description:

OBJECTIVE: Identify and demonstrate a new material system with suitable material properties to realize the advanced leading edges for use in reusable or long flight time hypersonic vehicles.

DESCRIPTION: Air Force-relevant applications include but not limited to sharp leading edges, rocket nozzles, throats and engine combustion parts are key components that enable hypersonic flight. These leading edges and high temperature parts experience high temperatures over 2200 degrees C at >Mach 8 flight conditions in high altitude air environment, resulting from aerothermally induced high heat flux. They further experience high ambient fluid velocities, mechanical vibrations, and thermal stresses from severe heat flux gradients and thermal shock. The materials that can survive such extreme conditions even for short exposure intervals are currently very limited. The state-of-the-art high temperature fiber reinforced composites, including C/C, C/SiC and SiC/SiC composites, cannot meet the challenges. Ultra-High-Temperature Ceramics (UHTC) materials based on refractory metal diborides (HfB₂ or ZrB₂) and containing optimum silicon carbide concentration (in either bulk or CMC form) have demonstrated the best performances to date. However, these alloys are still not thermal shock resistant enough for reliable use in a cyclic environment. In addition, they suffer from accelerating oxidation and ablation above 1800 degrees C due to volatilization of the glassy component. They also suffer tendency for spallation of the crystalline oxide partly due to phase transformations. The current UHTC technologies seem to have reached their limits, so new alloys are needed to address the property improvements required for the near future. Innovative material designs and possibly new fabrication technologies must be identified to enable applicability to

advanced sharp leading edges for hypersonic vehicles. The next generations of ultra-high temperature materials need to form high density, stable crystalline oxide phases and they should not contain volatile phases. These materials will also need to have high thermal shock resistance (i.e., requiring high temperature strength of 100 Ksi, fracture toughness exceeding 7 MPam^{1/2} and thermal conductivity exceeding 50 w/m²K). PHASE I: Identify candidate material systems and validate a proof-of-concept solution. Complete preliminary evaluation of the material performances with adequate laboratory evaluation approaches. This will require limited thermal-mechanical property evaluation from room temperature to at least 1600 degrees C. Oxidation and thermal shock resistance should be assessed torch testing in air up to 2200 degrees C. PHASE II: Expand on Phase I results by further improvements to the material and its properties database using experiments that simulated condition of hypersonic flight. Identify and develop a cost-effective manufacturing process and produce the hardware designs for a four-inch long leading edge and provide a description for commercialization that takes into account civilian use for land-based power turbines, nuclear industry and nuclear medicine, and range of wide band gap electronic materials systems. PHASE III DUAL USE APPLICATIONS: Transition the component technology to the Air Force system integrator or payload contractor, mature it for operational insertion, and demonstrate the technology in an operational level environment. Demonstration would include, but not be limited to, demonstration in a real system.